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Research

The Impact of Risk Management Strategies on Project Performance in Remote Area Construction Projects: An Applied Study in Saudi Arabia

Dedication

To my parents, whose prayers and support have been my guiding light.

To my family, for their patience and encouragement throughout this journey.

To all engineers contributing to the development of our beloved Kingdom.

Acknowledgment

I would like to express my deepest gratitude to my supervisor for his invaluable guidance and mentorship. My sincere thanks go to all the professionals who participated in this study, and to everyone who contributed to the completion of this research.

Abstract

This study aimed to identify the impact of risk management strategies on the performance of construction projects in remote areas of Saudi Arabia. Adopting a descriptive-analytical approach, the study utilized a questionnaire to collect data from a sample of 384 engineers and project managers. The results indicated a high level of application of risk management strategies, with "Risk Response" ranking first. The findings revealed a statistically significant effect of risk management strategies on project performance, explaining 41.5% of the variance. "Risk Monitoring and Control" emerged as the most influential factor on Time, Cost, and Quality performance. The study recommends enhancing continuous risk monitoring systems and adopting modern technological tools to address logistical challenges in remote areas.

Keywords: Risk Management, Project Performance, Remote Areas, Construction Sector, Saudi Arabia.

ملخص عربي

هدفت هذه الدراسة إلى التعرف على أثر استراتيجيات إدارة المخاطر على أداء المشاريع الإنشائية في المناطق النائية بالمملكة العربية السعودية. اعتمدت الدراسة المنهج الوصفي التحليلي، واستخدمت الاستبانة كأداة لجمع البيانات من عينة مكونة من 384 مهندساً ومدير مشروع. أظهرت النتائج مستوى مرتفعاً من تطبيق استراتيجيات إدارة المخاطر، حيث جاءت استراتيجية "الاستجابة للمخاطر" في المرتبة الأولى. كما كشفت النتائج عن وجود أثر ذو دلالة إحصائية لاستراتيجيات إدارة المخاطر على أداء المشاريع، حيث فسرت الاستراتيجيات 41.5% من التباين في الأداء. وتبين أن "مراقبة والتحكم في المخاطر" هو العامل الأكثر تأثيراً على الأداء من حيث الوقت، التكلفة، والجودة. أوصت الدراسة بضرورة تعزيز أنظمة المراقبة المستمرة للمخاطر وتبني أدوات تقنية حديثة للتعامل مع التحديات اللوجستية في المناطق النائية.

الكلمات المفتاحية: إدارة المخاطر، أداء المشاريع، المناطق النائية، قطاع التشييد، المملكة العربية السعودية.

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1. Introduction

1.1 Background of Remote Area Construction Projects in Saudi Arabia

The challenges and opportunities of the construction works of remote areas in Saudi Arabia have their own side. These projects are usually located in specific locations that are extremely remote to the centers and logistics, resource management and communication may be a major challenge. The geographical movement in Saudi Arabia is predominantly deserted and, therefore, remote infrastructure and human assets are normally rare (Sidawi, 2012). The huge area of the Kingdom and the extremes of climatic conditions impose additional pressures on the construction projects occupying the territories (Sidawi and Al-Sudairi, 2014).

Communication management is one of the biggest threats to the remote area construction projects. The traditional means of communication fails to accommodate the needs of the projects in such remote environments leading to a time wastage, lack of communication, and proper coordination of the projects. Sidawi (2012) observes that there is a poor communication system implemented in remote projects in Saudi Arabia, particularly in the regions of the country, including the Eastern Province where the mega energy and infrastructural projects are being undertaken. The adoption of the outdated communication tools also complicate the projects management process and must use more advanced systems such as computer based project management systems (Sidawi, 2012). These systems can improve the coordination and decision-making but have grave implementation problems regarding issues of organizational resistance and technology high costs of technology adoption.

There are also other issues, which are familiar to the works in the remote areas in Saudi Arabia, which are logistical problems, such as the difficulty of conveying materials, equipment and labor force to the remote regions. All these logistic issues increase the expenditure and duration involved in undertaking a project. These logistical and human resource challenges as noted by Sidawi and Al-Sudairi (2014) form a serious setback in slowing down the preparatory work of construction projects especially in far places where skilled workers are limited and costly.

This is in order to complicate the provision of quality development of the infrastructure in the remote locations. Such regions lack proper roads, electricity and water supply systems with no systems or they are very few hence making construction difficult (Sidawi, 2012). Using the Saudi Electric Company (SEC) as a case in point, large projects commissioned by this company are usually typified by delays due to lack of enough infrastructure, which negates the possibility of transporting materials and labor involved to execute the ventures (Sidawi, 2012).

However, there are opportunities of managing projects in these distant locations in an enhanced way by utilizing the potentials presented by the information technology and project management tools in a tactical way. It can eventually be integrated with proper computer-based systems that allow services to be streamlined in management and to remove inefficiencies that arise because of geographic isolation (Sidawi and Al-Sudairi, 2014). However, to ensure these systems work, it is necessary to introduce significant changes in the practices of management within the organization and introduce new technologies (Jastanyah, 2011). There has been an initiative in the recent years to make sure that better management mechanisms are implemented to minimize distance and inadequate facilities (Sidawi, 2011).

1.2 Importance of Risk Management in Construction Projects

The risk management process is extremely significant in construction work since there is an assurance that the work would be completed under the stipulated time, money and quality standards. The construction projects are the kind of project, which is likely to be exposed to any form of risk, including financial, environmental, legal, and technical (Kalkhoran, Liravi, and Rezagholi, 2014). Given the ambiguity and complexity of such projects, risk management may prove beneficial in mitigating the adverse consequences of the risks that they may impose on the project outcomes i.e. delays, cost overruns and subpar quality (Sharma, 2019).

The importance of risk management is premised on the fact that it assists in defining threats and opportunities at the early phase of a project life cycle, and, hence, enables the stakeholders of the project to make proactive decisions. The exposure of the construction managers to the outlined processes, such as risk identification, risk assessment, and risk response planning, creates a way of minimizing the likelihood of a risk taking place and minimizing the impact that it will impart in the project (Bayraktar, 2020). Sound risk

management would assist in the financial outlay security as well as assist the project to achieve safety, quality and environmental standards. In this instance, risk management can be used to avoid the delays in the construction process, which in most cases occur because of the unpredictable weather conditions or the unavailability of materials or a labour dispute (Mhetre, Konnur, and Landage, 2021).

Risk management also facilitates making decisions more effectively throughout the project lifecycle. With continuous tracking as well as reassessing the risks that occur, project managers can modify the approach to address the emerging problems promptly. Such a dynamic character has an advantage in supporting the project flow and reducing the chances of a project failure (Tiwari, 2018). Alongside, risk management methods will allow better estimating the project cost and timeframe, advancing the improved idea of the resources requirements and enhancing the project teams coordination (Al-Ajmi and Makinde, 2018).

Risk management of construction projects is not a response based procedure, as it is a proactive instrument that makes it easier to predict and control uncertainties. It enhances performance of projects, planning and reduction of the risk of failure and this is why it is also required in ensuring that construction projects are completed successfully (Bayraktar, 2020; Szymanski, 2017).

1.3 Challenges in Managing Risks in Remote Area Projects

The construction project in a remote area is loaded with numerous challenges related to the nature of operations in remote and normally undeveloped areas. This risks, such as logistical ones, environmental ones, and human resource ones in such projects are more severe than the ones experienced in urbanized locations. A project therefore requires the management of risks at an early stage so as to prevent time delays, cost overspending and poor quality of a project.

Mobilization of the resources is one of the most significant problems of the remote construction projects. This entails trials during transit of the construction materials and machinery to the site, trials during, employment and retention of skilled manpower. Usman (2015) underlines that the danger of mobilization is rather strong in remote places where the

transport and logistic infrastructure may be lacking or inadequate. Furthermore, the transportation costs are rather high as well since the routes are long, and the work has to be performed with the help of particular means or devices. This is also augmented by the fact that it would be hard to attract skilled workers to remote sites due to their high cost of living (McAnulty & Baroudi, 2010).

One more risk is also significant and is associated with procurement. The remote sites are not linked to a high number of local suppliers and vendors; hence the procurement risks were increased as they will be depending on faraway suppliers or will not be able to obtain materials at reasonable prices. According to Lin (2011), even though construction firms in remote areas are likely to encounter issues of procurement issue and lack of supply of material, it can translate to projects being postponed and lead to overruns. Others also need the materials to be within towns, an aspect which can lead to increased lead times and costs.

Other than the issues associated with logistics and procurement, there is the question of human resource. Hay et al. (2017) assert that the distribution of human resources is challenged in the construction projects in remote locations. The majority of these kinds of endeavors require to incorporate a mix of both local and routine workforce and although local workforce could assist in alleviating some of the expenses charged on the skilled workforce, yet the lack of local expertise could affect the overall project quality. In addition, workforce which is geographically spread is very difficult to control especially in communication and coordination.

The other major problem is the environmental and safety hazards that are posed by the remoteness of the place itself. In inaccessible locations, these projects frequently run in harsh and extreme conditions, e.g. desert, mountain setting and other harsh risky settings, which can lead to the higher susceptibility of the employees. Unsafe behavior could lead to accidents, and such accidents affect the health of employees and contribute to schedule slippage in the projects. According to Sharma (2018), it is possible to suggest that insufficient safety management and the absence of inter-team communication among the teams that operate in remote locations can lead to critical consequences, including injury or death.

One of the most serious problems of project management in the remote areas is communication. The arguments presented by McAnulty and Baroudi (2013) on the

misconceptions concerning poorly operating communication systems in distant areas, which may lead to poor project management, are similar. The distant site might be experiencing weak internet connections and this might drag the speed of making decisions and passing of relevant information about the project hence the project can be running due to a dragging effect.

The management of the risks in the remote construction projects is compromised by logistical, human resource, procurement, environmental, and communication concerns. In order to encounter such problems, it must be properly planned, adopt innovative risk management strategies and implement technology that is geared towards confidence in attaining project goals within the stipulated time, budget and quality limits.

1.4 Significance of the Study

This study is very significant to the academic field and to the industry because it provides an in-depth insight of the impacts of risk management plan in the execution of remote area construction projects in Saudi Arabia. The research will help in establishing the key risk factors, which are the most decisive towards the success of the project, as these projects have unique needs such as insufficient infrastructure, logistical issues and limitations in human resources. By examining the practices functionality in the existing practices of managing the risks, the study will present valuable details on how the practices can be refined to improve performance and efficiency of such projects.

This study will be of interest to the industry stakeholders to apply in the management of the risks to better suit the construction sites within the remote areas. It will provide advice to the construction managers, contractors and other stakeholders on the steps that can be taken to mitigate the risks caused by the costs, time, quality and safety. The input that this study brought to the project planning and implementation process can also contribute better project outcome and sustainability since it would make informed decision making in the project handling process.

In addition, the research will be considered applicable in risk management literature in construction and the hazardous and demanding setting specifically. The conclusions that will be made will play a role towards the gaps in the current research, and also provide a foundation

of future research in the field. It will contribute to the development of the knowledge about the regional issues and their mitigation with the assistance of the strategic risk management strategies, that is why it will be encouraged to carry out the analysis of the specific challenges of construction activities in the remote regions of Saudi Arabia. The research shall eventually lead to the growth and the success of the far-off construction projects that are paramount in the progress of the infrastructure in the inadequately developed and inaccessible areas.

Research Objectives, Questions and Hypotheses

1.5 Research Objectives

Based on the analysis, the objectives of this study are:

1. To determine the fact of risk management measures used in construction of projects in remote Saudi Arabia..
2. To identify the degree of project performance (Time, Cost, Quality, HSE, Stakeholder Satisfaction) in these remote projects.
3. To assess the effect of risk management plans (Identification, Analysis, Response, Monitoring) on the performance of the entire project.
4. To evaluate the individual impact of risk management dimension on individual performance of the project.

1.6 Research Questions

Main Question:

- What is the impact of risk management measures on performance of construction projects in remote locations of the Kingdom of Saudi Arabia?

Sub-Questions:

1. Is the effect of Risk Identification on project performance (Time, Cost, Quality, HSE, Satisfaction) statistically significant?
2. Do Risk Analysis and Assessment have a statistically significant effect on the performance of projects?
3. Are there statistically significant effects of Risk Response on performance of projects?
4. Does Risk Monitoring and Control have statistically significant effects on project performance?

1.7 Hypotheses

Main Hypothesis:

- **H0:** There is no statistically significant effect of risk management strategies on project performance in a remote area construction project at a significance level (0.05).

Sub-Hypotheses:

- **H1:** There is statistically significant effect of Risk Identification on project performance dimensions.
- **H2:** The dimension of project performance is significantly different with the effect of Risk Analysis & Assessment.
- **H3:** Risk Response has a statistically significant impact on the project performance dimension.
- **H4:** Risk Monitoring & Control has statistically significant effect on the project performance dimensions.

2. Literature Review

2.1 Risk Management Frameworks in Construction Projects

According to Lehtiranta (2014), risk management (RM) traditional approaches of the construction industry projects have been focused predominantly on single-firm companies. However, in the practical situation the factor to consider is the fact that construction projects tend to involve many organizations and it requires a collaborative approach in RM to be employed. The shift to multi-organizational RM structures is of utmost importance since it allows the inclusion of various stakeholders, which can be applied in terms of communication and flexibility. The paper has stated that conventional RM models like PMBOK are extensively used, albeit they need adjustments to the problems of multi-party environment. This kind of adaptation aids in dynamic risk management, which offers a mechanism of allocating responsibilities and responses in an effective manner and all along the project lifewames. The example provided by Lehtiranta shows that the strategies provided by RM have to be in sync with the team-based definition of the modern construction projects to enhance risk management and project success.

Zhao, Hwang, and Low (2015) created an enterprise risk management (ERM) model of construction companies, which is not specific to the risks in the project, but rather that of an enterprise. This is a holistic approach to RM that integrates operations that are executed both at the risk management of individual project and organizational wide risks management. The authors state that, by implementing the whole risk portfolio the firms will be in a better critical position to manage the uncertainties and improve the decisions-making processes on the construction projects. Their model of ERM emphasizes the role of construction companies related to wide outlook at risk such that the strategies ought to take into account the existing risks of the current project as well as risks that can influence the future sustainability of the organization.

This research has provided a proposal of a configurable project risk management framework that allowed project managers to adjust the RM practices to the peculiarities of a certain project (Firmsich 2017). It is the holistic model that encompasses all the stages of the conventional risk management procedure and adaptable, which can be modified to the requirements of the project. The approach particularly applies in construction industry

whereby the projects are more apt to assume very different forms in terms of the scope, the level of complexity and the risk involved. The organizational design of Firmsich allows the project managers modify the RM strategies according to the project development, ensuring that even at the project life cycle end, the risk mitigation can be deployed and be applied appropriately and in an effective manner as well.

Ahmed and Mohammed (2019) have developed a risk management model based on the Agile management idea of construction projects. A more agile and responsive RM model was delivered through the utilization of the traditional agile methods of the software development to construction. The authors considered Agile management practices such as sprint planning and sprint review helpful in the disclosure of risks and their overcoming more effectively, as the choice of management practices is premised on the concept of iterative development and this feedback. Specifically, it is a particularly useful method in construction works when changes are likely to be rather common and when the environment cannot be predicted under every circumstance. Agile structure assists project executives in reacting rapidly in the event that the hazards arise to improve project execution as well as reduce the probability of failure.

Such models as multi-organizational models to Agile models propose the importance of flexibility and risk management of the construction project integration. The introduction of these dynamic structures can significantly enhance the way the construction team can overcome risks and react towards alterations in specific constructions which are very complex and distant.

2.2

Challenges in Remote Area Construction Projects

Usman (2015) states that remote construction projects are also associated with the set of challenges due to the isolation of the worksite that affects the logistics and the management of the resources. Poor infrastructure e.g. roads, utility and communication facilities makes delivery of materials, equipment and labor even difficult to access these locations. Further, there may be a high level of delays and excessive costs due to high costs of transportation and problems of logistics in the case of large distances. Therefore, the functioning of remote area

construction venture must be thought through and under the capacity to embrace the constraint which are embodied by the environment.

Lin (2011) has discussed the problem of human resource distribution of remote construction projects. The most significant among them is the decision on whether to employ regular workers or hiring the domestic temporary workers. The staff that are at regular positions may be more trained and experienced but at high wages and re-locations it will lead to high costs. On the other hand, the local work force may not be qualified and this may undermine quality of this project. The research conducted by Lin emphasizes that there must be some balance between these aspects since the successful completion of projects in the remote areas is often characterized by the availability of skilled workforce and efficient Human resources management.

Hay et al. (2017) mentioned that the other important concern of remote construction projects management is the supply chain and acquisition of material. Distant locations may not have a single supplier within the region and delivery of materials could be extremely expensive and time consuming. This predicament is aggravated by the reality that the local weather is unpredictable and this complicates predicting demand of materials in such localities. To prevent these problems, Hay et al. (2017) have proposed that the contractor must, whenever possible, use a domestic supplier and tradespeople due to the fact that it could result in cost savings, as well as higher efficiency of the construction process.

Toth and Sebestyen (2014) remarks that project risk management is one of the issues of remote construction projects due to the lack of knowledge on the local conditions and the sudden increase in the scope of the project. In their study, they suggested an integrated risk management model that integrates traditional risk modelling with economic concerns whereby dynamic response of risks that may arise during the construction process can be realised. They stated that the risks monitoring and reassessment should be conducted on an ongoing and lifecycle basis of the project in question to make sure that the emerged issues could end up being alleviated in time.

According to Khodabakhshian and Re Cecconi (2022), it was also possible to process the capturing of risks in remote construction projects in a unique manner by utilizing a Process

Mining based model. This logical method of information is based on historical data and documentation of occurrences to conclude on the trends and patterns in the risk factors, based on which risks are predicted and managed more successfully. It is also artificial intelligent (AI) framework; it helps project managers to continue reviewing the risk and real-time change of strategies. The authors suppose that this sort of technologies will be implemented in the remote construction projects and will be in a position to enhance precision of risk management to a large extent making the project more successful.

All these papers work collectively on the intricate factors of risk management of remote area construction works. The transport problems of the human resource distribution and the problems of procurement, the inconveniences of the construction teams operating in remote locations require the innovative solution and flexible approach in risk management.

2.3 Impact of Risk Management on Project Performance

Risk management plays a significant role in enhancing performance of construction projects as it directly affects the key areas that involve the cost, time and quality. The intricacy in the construction projects justifies the necessity of an effective risk management to facilitate the success of the projects by providing their intended goals. Alsaadi and Norhayatizakuan (2021) found that the result of construction project adopting formal risk management practices will impress in terms of costs, time, and quality. Through their study in Oman they discovered that risk management is fundamental in providing on-time services within the stipulated budget and when risks are not addressed properly, they typically lead to huge losses in terms of money. To improve the project performance, the authors recommend the use of good project managers who possess ample knowledge in risk management.

The Prabu and Krishna (2017) validated the direct impacts of risk management on the performance of the project and provided reasoning that risks are included in projects in the establishment business due to the unique, complex and constrained nature. Without discovering them, evaluating them, and determining their corrective actions, these risks may have drastic effects on the results of projects. They noted that risk management can help the project managers to eliminate the likelihood of a project failure by managing risk proactively. This will imply identifying mitigatory measures that will curtail any type of disruption and

making sure that the projects are implemented within the budget and that it meets the quality requirement. The authors realistically pointed that the performance measures that are embraced in construction projects concerning time, cost and quality is greatly improved where successful practice of risk management is exercised in the inception stage.

The article of Mazurina et al. (2018) also concerns the impact of risk management on the performance of the construction projects in Malaysia. They discovered that project implementation that includes general risk management activities generate little delay, cost escalation, and quality. In particular, they have emphasized the significance of risk identification, risk analysis and risk control as the relevant components that culminate into realized higher project rates. The researchers identified that the successful completion of projects is the good outcome of systematically applied risk management as it is noted to help avoid uncertainties and facilitate the implementation process. However, they have pointed out that poor knowledge and poor communication of the risk management of the practices between the stakeholders of the project would hinder the effectiveness of these strategies.

According to Kamuzora (2024), the relationship that exists between the constituents of risk management and project performance in the city of Morogoro, Tanzania contribute to the importance of the presence of formal risk management procedures. The researchers found out that there was a significant positive relationship between the activity associated with risk management and the performance of construction projects in which the identified risk management activities were risk recognition, risk analysis and risk control. The analysis has mentioned that these practices directly result in the mitigation of the negative impact of the unforeseen risks that in their majority cause delays and cost overruns. As identified in the paper, risk management process is more holistic and the more methodical it is, the better the construction project works.

Moreover, speaking of the work of small construction firms, Amoah and Pretorius (2019) stressed that risk management is a direct factor to the success of a project, yet there may be instances of failure of implementing formal risk management procedures by the company. During their study in South Africa, they found out that even though a large percentage of small firms do not have a formal risk management process, the more the projects are risk management and the more it is likely to succeed. They further noted that appropriate risk

management which would have included early detection of risks and which should have included adequate risk mitigation measures would have been used to prevent the common project failures which involve defaulting on payments at the appropriate time and other labour issues.

All these findings paint a similar picture that risk management is not a purely reactive instrument, but a proactive instrument that has a great impact on the performance of construction project. When undertaken in good risk management practice; projects would be better placed to accommodate the uncertainties and complexity of the construction industry and subsequently the end outcome of the projects would be translated into more successful projects.

2.4 Risk Mitigation Strategies for Remote Area Projects

The successful contraction of remote area construction projects is also influenced by the factor of mitigation of risks because the geographical remoteness, poor infrastructure construction, and logistics are regarded as the natural factors of the project. Lin (2011) indicates that human resource allocation is one significant way of mitigating risks associated with remote construction projects. The paper found out that the world would consider replacing local workers with common project administrators, as potentially working in mitigating management failure or, overall project losses. The approach can lead to a higher control and decision making that should be done in managing the risks related to delay, quality issues and cost explosion of the projects. The issue of the selection of the suitable type of personnel due to the level of responsibility attributed to them arise to the fore in the work by Lin and this might significantly impact the success of the project.

During remote projects, it was clarified that the performance related to logistics is a crucial concern, and the primary risk factors in the case are logistics delays due to the transportation factors, disruption of the supply chain, and unpredictable weather (Firdausy, 2023). Both proactive and reactive risk mitigation strategies were associated with the research, the purpose of which was to improve the organization of logistics. Higher better planning and prediction of material deliveries were regarded as proactive strategies whereas reactive strategies relied on how schedules were to be shifted and contingency plans in case some

unforeseen events occurred. In conducting the study on Firdausy, there is the emphasis that moderation in the management of logistics risk would prevent significant financial and time hiccups that are common in the construction projects that are carried out in the remote areas.

Other than the logistical and manpower, Usman (2015) has also cited the role played by the procurement and mobilization risks management in the construction exercise in a remote location. In his study, he established that remote projects are very problematic as far as availability of materials and equipments that can lead to delays and escalated costs are concerned. The recommendation Usman made was the improvement of the planning and timing of procurement to minimize the risks of procurement as well as achieve delivery of the products within the deadlines. His other suggestion was the development of improved relations with the local suppliers and contractors to allow them to be more efficient in procurements and reduce their reliance on external sources.

Salah (2015) has proposed a more sophisticated model of risk management that involves the integration of the fuzzy set theory to enhance a better valuation and determination of the risk involved in the construction of projects. This model entails the identification of risk ownership and the identification of strategies that are employed to avert the risks both qualitatively and quantitatively. The model of Salah can be used extensively in the construction activities that occur in remote regions where measuring the risks was not easy since the data was not available, and the context is distinguished. The implementation of the fuzzy set theory will provide the project managers with the conception of the possible effect of the risks; as such, they will choose the mitigating measures that are most agreeable to implement.

In addition to this, Kamane and Mahadik (2013) also gave an insight on some risk mitigation strategies such as risk aversion, risk retention and risk transfer. These recommendations when combined based on the risk involved, they suggested that these measures be applied in handling complex construction projects especially in the remote areas. Their research concluded that a well-established communication and risk management process including comprehensive review of risks at each stage of a project may be important in the improvement of a project deliverable.

All these researches have resulted in the need to develop some risk mitigation techniques that should be deployed when it comes to undertaking remote construction initiatives. Certain risks, such as personnel management, logistics, procurement, and environmental consideration may lead to influence of the project performance, reduce delays and allow the construction teams to work within budget.

3. Methodology

The design of this research study was based on a quantitative approach, specifically cross-sectional surveys. The main objective was to collect data on risk management practices in construction projects in remote areas, the challenges they face, and the application of existing practices. The primary data collection technique was a questionnaire, which allowed for the gathering of diverse insights from professionals working on construction projects in rural areas. The questionnaire was designed systematically, enabling the analysis of specific variables related to risk management practices and their impact on project outcomes.

3.1 Study Approach

To achieve the study objectives, the researcher adopted a descriptive-analytical approach. This approach is defined as a method that seeks to describe, analyze, and interpret the current state of a phenomenon by studying the reality or phenomenon as it exists and accurately describing it. This approach is not limited to data collection and tabulation but extends to analysis, interpretation, and drawing conclusions. The researcher chose this approach because it is suitable for the nature of the study, which aims to determine the impact of risk management strategies on project performance using quantitative data. Quantitative research is defined as the systematic study of phenomena through the collection of quantifiable data and the application of statistical, mathematical, or computational techniques. This allows for the transformation of opinions and observations into numerical data that can be statistically analyzed to generalize the findings.

3.2 Study Design

This study employs the "research ray" model in its design, utilizing a cross-sectional time horizon. A cross-sectional study involves analyzing data from a population at a specific point in time. This design is optimal for studying large populations within a limited timeframe and under specific resource constraints. It enables the researcher to analyze the relationship between variables, specifically risk management strategies and project performance, at a single point in time, thus providing an overview of the current state of the Saudi construction sector.

3.3 Study Population

The study population is defined as the entire group of individuals or entities that share common characteristics of interest to the researcher. The study population consists of professionals working in the engineering and construction sector in Saudi Arabia, specifically engineers and project managers in the private sector.

The study population is characterized by significant growth and development resulting from government localization initiatives. Recent statistics indicate a 157% increase in the number of Saudi engineers working in the private sector over the past five years, rising from 47,000 in 2020 to over 121,000 in 2025. This surge is attributed to the decision to raise the Saudization rate in engineering professions to 30% of the total workforce in companies with five or more engineers. The total number of employees in the private sector is 11.8 million, with mega-projects such as NEOM and the Red Sea Project driving the demand for qualified engineers.

Table 3.1: Characteristics of the Engineering Labor Market in Saudi Arabia (2025)

Metric	Statistic
Total Saudi Engineers (Private Sector)	> 121,000
Growth Rate (Last 5 Years)	157%
Council of Engineers Members	460,000
Saudi Membership %	31%
Non-Saudi Membership %	68%
Top Non-Saudi Nationalities	Egyptian (29%), Indian (21%), Pakistani (13%), Sudanese (7%)
Annual Graduates	~4,000 Saudi Engineers
Unemployed Saudi Engineers	5,000 – 12,000 (Est.)
Target Emiratization Rate (2025)	30%

Source: Al-Hamdi, A. (2025). A 157% jump in the Emiratization of Saudi engineers in the private sector in 5 years. Al-Eqtessadia.

3.4 Geographical Domain and its Characteristics

The geographic scope of this study is the Kingdom of Saudi Arabia. The construction sector in Saudi Arabia is currently experiencing tremendous expansion driven by the ambitious Vision 2030 projects. The data collection and analysis process for this study was estimated to take six weeks.

3.5 Study Sample

The study sample is a subset of the study population, selected to be representative of the entire group. Due to the large size of the study population (over 460,000 members of the Council of Engineers), the researcher used Robert Mason's formula to determine the appropriate sample size. The sample was selected using stratified random sampling to ensure comprehensive representation of various job titles and types of organizations.

The sample size (n) was calculated using the following formula attributed to Robert Mason:

$$n = \frac{M}{\left[\frac{S^2 \times (M-1)}{p \times q} \right] + 1}$$

Where:

- **M (Community Size):** 460,000 (Total Council Members)
- **S (Standard Score):** 1.96 (Corresponding to a 95% confidence level and 0.05 error rate).
- **p (Feature Availability):** 0.50 (assumed for maximum variability).
- **q (Remaining Percentage):** 0.50.

Using these values, the required sample size was determined to be 384 participants. This ensures that the results are statistically significant and generalizable to a wider segment of the population with a 95% confidence level.

3.6 Study Instrument Measurement

Validity and Reliability Testing:

To ensure the validity of the questionnaire, a pilot study was conducted with a small experimental sample prior to full distribution. This helped identify ambiguous items and ensured that the instrument accurately measured the intended concepts. Reliability was assessed using Cronbach's alpha coefficient.

Data Processing:

The collected data were entered into SPSS version 25 (Statistical Package for the Social Sciences) for analysis.

Assessment Scale:

Questionnaire items were measured using a five-point Likert scale: (Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2, Strongly Disagree = 1).

To interpret the arithmetic means, the range was calculated as follows:

$$(5 - 1) \sqrt{3} = 1.33.$$

Classification based on the modified Likert scale:

1. **Low:** Ranges from 1.00 to less than 2.33.
2. **Average:** Ranges from 2.34 to less than 3.67.
3. **High:** Ranges from 3.68 to 5.00.

3.7 Study Tool Design

The study tool was designed based on the literature review and study objectives. It consists of two main sections:

1. **Demographic Information:** Capturing Job Title, Experience, Organization Type, Company Classification, Location, and Project Value.
2. **Main Variables:**
 - **Independent Variable (Risk Management Strategies):** Divided into Risk Identification, Risk Analysis, Risk Response, and Risk Monitoring.
 - **Dependent Variable (Project Performance):** Divided into Time, Cost, Quality, HSE (Health, Safety, Environment), and Stakeholder Satisfaction.

3.8 Data Analysis

Data analysis was conducted, including the application of descriptive and inferential statistical measures. Descriptive statistics provided an overview of key risk management practices, trends, and patterns in various remote area projects. Inferential statistics, specifically regression analysis, were used to identify correlations between variables, including how certain risk management strategies impact project success (in terms of time, cost, and quality). These methods allowed for the identification of key indicators for an effective approach to managing risks in remote construction projects.

3.9 Ethical Considerations

Ethical guidelines were followed in the study methodology. Participants were informed of the study's purpose, and their participation was voluntary. Confidentiality was guaranteed, and information was securely stored. Participants were also assured that they would not face any consequences should they choose to withdraw from the study. The study adhered fully to all ethical guidelines pertaining to research conducted on human subjects.

This approach ensured the study's comprehensiveness and provided valuable insights into the reasons behind the success of risk management strategies in remote construction projects. The results have contributed to improving knowledge regarding opportunities to improve the management of construction projects in remote locations, reduce risks, and achieve successful outcomes.

3.10 *Statistical Analysis Software*

The data were analyzed using SPSS version 25. The following statistical tests were used:

- Frequencies and percentages: to describe the demographic characteristics of the study sample.
- Arithmetic mean and standard deviation: to determine the level of response and dispersion of the study variables.
- Cronbach's alpha coefficient: to measure the reliability and internal consistency of the questionnaire.
- Pearson's correlation coefficient: to measure the internal structure (construction validity) and the relationships between variables.
- Simple and multiple linear regression: to test the study hypotheses and determine the effect of the independent variable on the dependent variable.

3.11 *Pilot Testing*

The questionnaire was piloted with a small group of participants before the actual survey. This pilot test allowed for confirmation of the clarity of the questions and their suitability for obtaining the required data. It also revealed potential problems with the questionnaire, including ambiguous questions or unclear answers. The feedback from the pilot group was used to improve the questionnaire and enhance its reliability and validity.

3.12 *Information Protection and Information storage*

A database was created to store all information using a password system. The anonymity of participants was maintained to ensure their identities could not be determined and that the data would not be used for any purpose other than scientific research. This contributed to the ethical conduct of the study and the protection of participant data confidentiality.

These research tools, such as questionnaires, statistical software, pilot testing, and reliability tests, were essential in enhancing the strength of the study and the credibility of the results.

3.13 *Scope of the Study*

The scope of this study was limited to examining risk management strategies used in construction projects in remote and isolated areas. The study targeted construction professionals, specifically project managers, engineers, and contractors working in these areas. It addressed various categories of risks, including logistical, environmental, geopolitical, and occupational risks, and explored how these risks were identified, assessed, and mitigated. The projects under study were limited to those located in rural, mountainous, and environmentally sensitive areas, where risks were particularly significant due to weak infrastructure, limited resources, and uncontrollable external conditions. This study sought to provide valuable information on the effectiveness of current risk management methodologies, and how to enhance risk reduction in such challenging environments.

4. Results and Analysis

This chapter presents the results of the statistical analysis of the data collected from the study sample. The analysis begins by describing the demographic characteristics of the respondents, followed by validating the reliability of the research instrument using Pearson correlation coefficients and Cronbach's alpha. Descriptive statistics (means and standard deviations) are then used to describe the study variables, dimensions, and items. Finally, the chapter concludes by testing the main and sub-hypotheses of the study using regression analysis to determine the impact of risk management strategies on project performance.

4.1 Demographic Characteristics

The demographic characteristics of the study sample were analyzed to understand the respondents' backgrounds. Table 4.1 shows the frequencies and percentages for job title, years of experience, type of organization, company classification, project location, and average project value.

Table 4.1 Demographic Characteristics of the Study Sample (N=384)

Variable	Category	Frequency	Percentage (%)
Job Title	Project Manager	76	19.8
	Site Engineer	113	29.4
	Construction Manager	60	15.6
	Planning/Cost Engineer	78	20.3
	PMO Manager	39	10.2
	Executive/Owner	18	4.7
Years of Experience	Less than 5 years	57	14.8
	5-10 years	136	35.4
	11-15 years	117	30.5
	16-20 years	55	14.3
	More than 20 years	19	4.9
Type of Organization	Contractor	229	59.6
	Consultant	96	25.0
	Owner/Gov Entity	40	10.4
	Real Estate Developer	19	4.9

Company Classification	Grade 1	191	49.7
	Grade 2	116	30.2
	Grade 3	57	14.8
	Grade 4 or less	20	5.2
Project Location	Urban Areas	114	29.7
	Remote Areas	270	70.3
Project Value (SAR)	< 50 Million	38	9.9
	50- 250 Million	78	20.3
	251- 500 Million	98	25.5
	501 Million- 1 Billion	77	20.1
	> 1 Billion	93	24.2

The results in Table 4.1 indicate that the sample is well-distributed across different roles, with site engineers (29.4%) and planning/cost engineers (20.3%) forming the largest groups, ensuring a diversity of operational perspectives. Regarding experience, the majority of participants possess extensive experience, with 65.9% having between 5 and 15 years of experience, which strengthens the credibility of the responses concerning complex risk management practices. Most participants work for contracting companies (59.6%), followed by consulting firms (25.0%). Nearly half of the organizations (49.7%) fall into the first category, demonstrating that the data reflects the practices of large, established companies. Notably, 70.3% of the projects are located in remote areas, which aligns perfectly with the study's focus. Finally, the projects are of significant value, with 69.8% exceeding SAR 250 million, indicating that the study derives valuable insights from large-scale infrastructure development projects.

4.2 Measure Truthfulness

To ensure the accuracy and reliability of the data collection instrument, the questionnaire's validity was assessed using two main methods: face validity and construct validity.

4.2.1 Apparent Honesty

Face validity was verified by presenting the initial draft of the questionnaire to a panel of experts and the academic supervisor. Their feedback and revisions were taken into account to improve the wording, clarity, and relevance of the items, ensuring that the instrument outwardly measures the intended concepts of risk management and project performance.

4.2.2 Constructivist Honesty

Construct validity was assessed by calculating Pearson's correlation coefficient between the score of each item and the overall score for the dimension to which it belongs. This test determines the internal consistency and structural validity of the questionnaire.

A. Independent Variable (Risk Management Strategies)

The internal consistency of the independent variable was tested by correlating each item within the four dimensions of risk management (identification, analysis, response, and monitoring) with the overall score for that dimension.

Table 4.2 Pearson Correlation Coefficients for Independent Variable Items

Dimension	Item	Correlation
Risk Identification	Systematic identification of potential risks	.708**
	Use of effective tools (brainstorming)	.591**
	Risks documented in Risk Register	.783**
	Reviewing data from previous projects	.510**
	Involvement of key stakeholders	.805**
Risk Analysis	Analyzing probability of occurrence	.666**
	Assessing impact on objectives	.686**
	Using qualitative analysis (P-I Matrix)	.643**
	Prioritizing risks based on Score	.660**
	Applying quantitative analysis (Monte Carlo)	.655**
Risk Response	Developing clear response strategies	.649**
	Assigning a Risk Owner	.720**
	Allocating contingency reserves	.667**
	Using risk transfer strategies	.566**
	Proactive response plans for logistics	.664**
Risk Monitoring	Continuous monitoring of risks	.634**
	Regular meetings to review risk status	.723**
	Tracking risk triggers	.863**
	Identifying new risks during execution	.778**
	Regular updates to Risk Register	.736**

Note: ** *p.vlaue* < 0.01; * *p.vlaue* < 0.05

Table 4.2 shows that all items comprising the dimensions of the independent variable (risk identification, analysis, response, and monitoring) exhibit positive and statistically significant correlations with their respective dimension scores at the 0.01 level. Correlation coefficients range from moderate to strong, with the highest correlation observed for the item "Tracking risk triggers" in the monitoring dimension ($r=0.863$), and the lowest correlation for the item "Reviewing data from previous projects" in the identification dimension ($r=0.510$). These results indicate a high degree of construct validity, confirming that the items accurately measure the risk management concepts they were designed to assess.

B. Dependent Variable (Project Performance)

The internal consistency of the dependent variable was tested by correlating each item within the five performance dimensions (time, cost, quality, health, safety, environment, and stakeholder satisfaction) with its overall dimension score.

Table 4.3 Pearson Correlation Coefficients for Dependent Variable Items

Dimension	Item	Correlation
Time Performance	Projects completed within schedule	.901**
	Minimal time overruns	.873**
	Achieving key milestones	.886**
	Risk mgmt reduces delays	.721**
	Efficient mgmt of logistical delays	.859**
Cost Performance	Projects completed within budget	.822**
	Minimal cost overruns	.896**
	Cash flow managed effectively	.909**
	Risk mgmt controls costs	.846**
	Controlling remote area costs	.871**
Quality Performance	Meets quality standards	.826**
	Low rate of rework/defects	.864**
	Risk mgmt prevents quality problems	.855**
	Materials comply with specs	.916**
	Meets technical requirements	.926**
HSE Performance	Maintaining high HSE standards	.874**
	Very low rate of accidents	.929**

	Risk mgmt addresses safety risks	.868**
	Adherence to environmental regs	.874**
	Team well-trained on safety	.738**
Stakeholder Sat.	Client complete satisfaction	.845**
	Effective expectation mgmt	.821**
	Effective communication	.906**
	Disputes rare/resolved quickly	.936**
	Project considered successful	.792**

Note: ** *p.vlaue* < 0.01; * *p.vlaue* < 0.05

The results in Table 4.3 show strong and statistically significant positive correlations between all items of the dependent variable and its dimensions at the 0.01 level. The correlation coefficients are remarkably high, with some exceeding 0.90, such as "Few conflicts with stakeholders" (r=0.936) and "Significantly low accident rate" (r=0.929). This confirms that the items are consistent and valid indicators of time, cost, quality, health, safety, environment, and stakeholder satisfaction performance, demonstrating a robust construct for the dependent variable.

C. Total Grade

To validate the overall construct, the correlation coefficient between the overall score for each major dimension and the overall questionnaire score was calculated.

Table 4.4 Pearson Correlation Between Study Dimensions and Total Score

Dimension	Correlation with Total Score
Risk Identification	.678**
Risk Analysis & Assessment	.715**
Risk Response	.657**
Risk Monitoring & Control	.855**
Overall Risk Mgmt Strategies	.846**
Time Performance	.941**
Cost Performance	.936**
Quality Performance	.918**
HSE Performance	.957**
Stakeholder Satisfaction	.946**

Overall Project Performance	.966**
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*Note: ** p.vlaue < 0.01; * p.vlaue < 0.05*

Table 4.4 shows strong and statistically significant correlations between all study dimensions and the total questionnaire score at a significance level of 0.01. The dependent variable dimensions generally show higher correlations with the total score (e.g., occupational health and safety performance $r=0.957$) compared to the independent variable dimensions, although all correlations are substantial. These results confirm that all dimensions contribute significantly to the overall structure being measured, thus confirming the instrument's structural integrity and suitability for the study.

4.3 Stability of Measurement (Reliability)

The reliability of the study instrument was assessed using Cronbach's alpha coefficient to measure the internal consistency of the scale items. This test determines the degree to which the questionnaire items consistently measure the same structure.

Table 4.5 Cronbach's Alpha Coefficients for Study Variables and Dimensions

Variable / Dimension	Number of Items	Cronbach's Alpha	Stability Level
Independent Variable: Risk Management	20	0.886	High
1. Risk Identification	5	0.714	High
2. Risk Analysis & Assessment	5	0.761	High
3. Risk Response	5	0.722	High
4. Risk Monitoring & Control	5	0.727	High
Dependent Variable: Project Performance	25	0.981	Very High
1. Time Performance	5	0.892	High
2. Cost Performance	5	0.916	Very High
3. Quality Performance	5	0.924	Very High
4. HSE Performance	5	0.901	Very High
5. Stakeholder Satisfaction	5	0.910	Very High
Grand Total (All Items)	45	0.971	Very High

Table 4.5 presents the reliability statistics for the study dimensions and the overall scale. Cronbach's alpha values for the main variables are very high, with an alpha coefficient of 0.886

for the independent variable (risk management) and 0.981 for the dependent variable (project performance). The sub-dimensions also demonstrate high reliability, ranging from 0.714 (risk identification) to 0.924 (quality performance). The overall Cronbach's alpha coefficient of 0.971 indicates excellent internal consistency, confirming the questionnaire's high reliability and consistency in data collection within this research context.

4.4 Characterization of the Study Variables

This section presents the descriptive statistics for the study variables, including the arithmetic mean, standard deviation, rank, and relative importance level. The analysis is based on responses from the study sample (n = 384). The arithmetic mean is interpreted according to the following scale: "Low" (1.00–2.33), "Medium" (2.34–3.67), and "High" (3.68–5.00). This classification allows for the assessment of the prevalence and application of risk management strategies and the performance level of construction projects in remote areas.

4.4.1 Characterization of the Independent Variable (Risk Management Strategies)

Table 4.5 presents the reliability statistics for the study dimensions and total scale. The Cronbach's Alpha values for the main variables are exceptionally high, with the Independent Variable (Risk Management) achieving 0.886 and the Dependent Variable (Project Performance) achieving 0.981. The sub-dimensions also demonstrate strong reliability, ranging from 0.714 (Risk Identification) to 0.924 (Quality Performance). The Grand Total Cronbach's Alpha of 0.971 indicates excellent internal consistency, confirming that the questionnaire is highly reliable and stable for data collection in this research context.

Table 4.6 presents the descriptive statistics for the independent variable "Risk Management Strategies" and its four dimensions: risk identification, risk analysis and assessment, risk response, and risk monitoring and control.

Table 4.6 Descriptive Statistics for the Independent Variable (Risk Management Strategies)

Dimension / Item	Mean	Std. Deviation	Rank	Importance Level
First Dimension: Risk Identification	4.05	0.760	3	High
1. Systematic identification of potential risks before project start	4.19	0.991	1	High

2. Use of effective tools (brainstorming, checklists)	4.13	0.981	2	High
3. All identified risks are documented in a formal Risk Register	4.08	1.031	4	High
4. Reviewing data from previous similar projects	3.74	1.157	5	High
5. Involvement of key stakeholders in risk identification	4.10	1.043	3	High
Second Dimension: Risk Analysis & Assessment	4.05	0.695	2	High
6. Analyzing the probability of occurrence for each risk	4.01	1.042	4	High
7. Assessing the impact of each risk on project objectives	4.12	0.958	1	High
8. Using qualitative analysis methods (P-I Matrix)	4.01	1.038	4	High
9. Prioritizing risks based on Risk Score	4.09	0.985	2	High
10. Applying quantitative analysis (Monte Carlo)	4.03	0.986	3	High
Third Dimension: Risk Response	4.08	0.651	1	High
11. Developing clear response strategies (Avoid, Mitigate, Transfer)	3.95	1.080	4	High
12. Assigning a Risk Owner for each major risk	3.66	1.212	5	Average
13. Allocating sufficient contingency reserves for time and cost	4.17	0.881	3	High
14. Using risk transfer strategies (insurance/contracts) effectively	4.42	0.858	1	High
15. Proactive response plans for logistical risks in remote areas	4.19	0.996	2	High
Fourth Dimension: Risk Monitoring & Control	4.00	0.715	4	High

16. Continuous monitoring of risks throughout project lifecycle	3.87	1.085	5	High
17. Regular meetings to review risk status	4.02	0.980	3	High
18. Tracking risk triggers for early warning	3.91	0.986	4	High
19. Identifying new risks during execution phase	4.13	0.902	1	High
20. Regular updates to Risk Register and Management Plan	4.05	0.942	2	High
General Arithmetic Mean (Total Independent Variable)	4.04	0.596	-	High

The results in Table 4.6 indicate a generally high level of risk management strategy implementation in construction projects in remote areas of Saudi Arabia, with an overall average score of 4.04. The risk response dimension topped the list (average 4.08), largely driven by the effective use of risk transfer strategies (average 4.42), which received the highest score among all items. This reflects the reliance on contracts and insurance to manage uncertainties in remote areas. In contrast, the risk monitoring and control dimension came in last (average 4.00), although still at a high level. Notably, the item "Assigning a person responsible for each major risk" received the lowest average score (3.66), falling within the "average" category, indicating potential areas for improvement in assigning responsibilities. The high score for identifying new risks during implementation (average 4.13) suggests that project teams are responsive and adaptable to the dynamic nature of remote environments.

4.4.2 Characterization of the Dependent Variable (Project Performance)

Table 4.7 presents the descriptive statistics for the dependent variable "project performance" and its five dimensions: time, cost, quality, health, safety and environment, and stakeholder satisfaction.

Table 4.7 Descriptive Statistics for the Dependent Variable (Project Performance)

Dimension / Item	Mean	Std. Deviation	Rank	Importance Level
First Dimension: Time Performance	3.93	0.850	4	High

21. Projects in remote areas are completed within planned schedule	3.90	1.010	3	High
22. Minimal time overruns (delays) in remote area projects	3.88	1.085	4	High
23. Achieving key milestones on specified dates	3.91	0.995	2	High
24. Risk management contributes to reducing time delays	4.12	0.845	1	High
25. Efficient management of logistical delays (material/labor)	3.82	1.156	5	High
Second Dimension: Cost Performance	3.98	0.829	3	High
26. Projects are completed within approved budget	4.04	0.903	2	High
27. Minimal cost overruns in remote area projects	3.90	0.977	4	High
28. Cash flow is managed effectively	3.81	1.053	5	High
29. Risk management is effective in controlling project costs	4.04	0.943	2	High
30. Controlling additional costs associated with remote areas	4.11	0.877	1	High
Third Dimension: Quality Performance	4.02	0.809	2	High
31. Final project meets quality standards and specifications	4.01	0.946	3	High
32. Low rate of rework or defects in remote projects	4.04	0.913	2	High
33. Risk management prevents quality-related problems	4.01	0.938	3	High
34. Quality of supplied materials complies with specifications	3.98	0.945	5	High
35. Project meets all technical and functional requirements	4.07	0.885	1	High

Fourth Dimension: HSE Performance	4.20	0.499	1	High
36. Maintaining high HSE standards at remote sites	4.06	0.893	5	High
37. Very low rate of accidents or injuries	4.27	0.817	2	High
38. Risk management effectively addresses safety risks	4.33	0.782	1	High
39. Adherence to environmental regulations in sensitive areas	4.20	0.843	3	High
40. Work team is well-trained on safety protocols for remote sites	4.15	0.818	4	High
Fifth Dimension: Stakeholder Satisfaction	3.89	0.518	5	High
41. Client expresses complete satisfaction with outcomes	3.81	0.938	4	High
42. Effective management of stakeholder expectations	3.93	0.793	2	High
43. Effective communication despite geographical distance	3.90	0.797	3	High
44. Disputes with stakeholders are rare and resolved quickly	3.74	0.944	5	High
45. Project is considered successful by all major parties	4.09	0.740	1	High
General Arithmetic Mean (Total Dependent Variable)	4.00	0.580	-	High

Table 4.7 shows that the overall performance of projects in remote areas is high, with an overall arithmetic mean of 4.00. Health, safety, and environment (HSE) performance emerged as the highest-rated dimension (average 4.20), demonstrating a strong focus by the sector on safety and environmental compliance. The item "Managing risks effectively to address safety hazards" scored the highest (4.33) across the entire dependent variable. Quality performance came in second (average 4.02), indicating that despite the challenges of remote areas, technical standards are largely maintained. Stakeholder satisfaction ranked lowest (average 3.89), with "Disagreements with stakeholders" scoring the lowest (3.74), which may reflect the

communication difficulties and expectations management challenges inherent in remote projects. While time and cost performance were highly rated, they ranked lower than quality and HSE, highlighting that logistical and budgetary pressures remain the most challenging aspects of construction in remote areas.

While time and cost performance were highly rated, they ranked lower than quality, health, safety, and the environment, underscoring that logistical and budgetary constraints remain the most challenging aspects of construction in remote areas.

4.5 Correlation Matrix

Relationship between Independent and Dependent Variables

The correlation matrix below (Table 4.8) illustrates the relationships between the independent variable (risk management strategies) and its dimensions, and the dependent variable (project performance) and its dimensions. Pearson's correlation coefficient was used to determine the strength and direction of these relationships.

Table 4.8 Correlation Matrix between Independent and Dependent Variables

Variables	Mean: Time Perf.	Mean: Cost Perf.	Mean: Quality Perf.	Mean: HSE Perf.	Mean: Stakeholder Sat.	Mean: Total Performance
Mean: Risk Identification	.466**	.458**	.475**	.252**	.104*	.462**
Mean: Risk Analysis & Assessment	.473**	.454**	.461**	.265**	.156**	.471**
Mean: Risk Response	.453**	.475**	.473**	.321**	.149**	.482**
Mean: Risk Monitoring & Control	.774**	.712**	.722**	.473**	.263**	.760**
Mean: Overall Risk Mgmt Strategies	.642**	.621**	.631**	.387**	.198**	.644**

Note: ** p.vlaue < 0.01; * p.vlaue < 0.05

The results in Table 4.8 indicate statistically significant positive correlations between the independent and dependent variables at the 0.01 level. Risk monitoring and control showed the strongest correlation with project performance dimensions, particularly time performance ($r=0.774$) and quality performance ($r=0.722$). In contrast, stakeholder satisfaction showed the weakest correlations with risk management dimensions, with risk identification showing a low correlation (0.104). The overall correlation between overall risk management strategies and overall project performance is strong ($r=0.644$), indicating that the application of these strategies is closely linked to improved project outcomes in remote areas.

4.6 Effect of the Independent Variable on the Dependent Variable

To test the study hypotheses and determine the impact of risk management strategies on project performance, simple and multiple linear regression analyses were conducted.

4.6.1 Main Hypothesis

Hypothesis: Risk management strategies have a statistically significant impact on project performance in construction projects in remote areas at the ($\alpha<0.05$) level.

Table 4.9 Model Summary and ANOVA for Main Hypothesis

Model	R	R Square	Adjusted R Square	F	<i>p.vlaue</i>
1	.644a	.415	.413	270.793	.000b

The results in Table 4.9 show a correlation coefficient (R) of 0.644 and a coefficient of determination (R^2) of 0.415. This indicates that risk management strategies explain 41.5% of the variance in project performance. The F-value of 270.793 is statistically significant at the 0.000 level, confirming the model and supporting the main hypothesis that risk management has a significant positive impact on project performance.

4.6.2 Sub-Hypothesis 1: Effect on Time Performance

Hypothesis: There is a statistically significant effect of Risk Management dimensions on Time Performance.

Table 4.10 Multiple Regression Analysis: Effect of Risk Dimensions on Time Performance

Model	Unstandardized Coeff (B)	t	<i>p.vlaue</i>
(Constant)	0.079	0.415	0.678

Risk Identification	0.120	2.152	0.032
Risk Analysis	0.066	0.998	0.319
Risk Response	-0.094	-1.446	0.149
Risk Monitoring	0.870	18.223	0.000
$R^2 = 0.610$	F = 148.017	p.vlaue = .000	

The model explains 61.0% of the variance in time performance ($R^2 = 0.610$). Analysis shows that risk monitoring and control ($B = 0.870$, $p = 0.000$) and risk identification ($B = 0.120$, $p = 0.032$) have a statistically significant positive impact on time performance. Risk and response analysis did not show a uniquely statistically significant contribution to this model.

4.6.3 Sub-Hypothesis 2: Effect on Cost Performance

Hypothesis: There is a statistically significant effect of Risk Management dimensions on Cost Performance.

Table 4.11 Multiple Regression Analysis: Effect of Risk Dimensions on Cost Performance

Model	Unstandardized Coeff (B)	t	p.vlaue
(Constant)	0.333	1.623	0.105
Risk Identification	0.124	2.059	0.040
Risk Analysis	0.004	0.054	0.957
Risk Response	0.051	0.722	0.471
Risk Monitoring	0.731	14.171	0.000
$R^2 = 0.521$	F = 103.265	p.vlaue = .000	

The model explains 52.1% of the variance in cost performance. Both risk monitoring and control ($B=0.731$, $p\text{-value} = 0.000$) and risk identification ($B=0.124$, $p\text{-value} = 0.040$) are significant indicators. This suggests that continuous monitoring and early detection are crucial to ensuring that remote projects remain within budget.

4.6.4 Sub-Hypothesis 3: Effect on Quality Performance

Hypothesis: There is a statistically significant effect of Risk Management dimensions on Quality Performance.

Table 4.12 Multiple Regression Analysis: Effect of Risk Dimensions on Quality Performance

Model	Unstandardized Coeff (B)	t	p.vlaue
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(Constant)	0.426	2.168	0.031
Risk Identification	0.153	2.651	0.008
Risk Analysis	0.002	0.032	0.975
Risk Response	0.015	0.228	0.820
Risk Monitoring	0.726	14.698	0.000
$R^2 = 0.539$	F = 110.655	p.vlaue = .000	

The model explains 53.9% of the variance in quality performance. As with time and cost, both risk monitoring ($B=0.726$) and risk identification ($B=0.153$) are important indicators, underscoring their role in maintaining technical standards.

4.6.5 Sub-Hypothesis 4: Effect on HSE Performance

Hypothesis: There is a statistically significant effect of Risk Management dimensions on HSE Performance.

Table 4.13 Multiple Regression Analysis: Effect of Risk Dimensions on HSE Performance

Model	Unstandardized Coeff (B)	t	p.vlaue
(Constant)	2.783	17.749	0.000
Risk Identification	-0.005	-0.105	0.916
Risk Analysis	-0.031	-0.563	0.574
Risk Response	0.084	1.548	0.122
Risk Monitoring	0.306	7.753	0.000
$R^2 = 0.229$	F = 28.126	p.vlaue = .000	

The model explains 22.9% of the variance in health, safety, and environmental performance. Only risk monitoring and control ($B=0.306$, $p = 0.000$) showed a statistically significant effect. The constant value is remarkably high (2.783), indicating that health, safety, and environmental standards are generally high regardless of specific risk management strategies, likely due to strict adherence to regulations.

4.6.6 Sub-Hypothesis 5: Effect on Stakeholder Satisfaction

Hypothesis: There is a statistically significant effect of Risk Management dimensions on Stakeholder Satisfaction.

Table 4.14 Multiple Regression Analysis: Effect of Risk Dimensions on Stakeholder Satisfaction

Model	Unstandardized Coeff (B)	t	<i>p.vlaue</i>
(Constant)	3.132	17.537	0.000
Risk Identification	-0.059	-1.117	0.265
Risk Analysis	0.059	0.949	0.343
Risk Response	-0.001	-0.023	0.981
Risk Monitoring	0.192	4.265	0.000
$R^2 = 0.073$	F= 7.413	p.vlaue= .000	

The model explains only 7.3% of the variance in stakeholder satisfaction ($R^2 = 0.073$). Risk monitoring is the only statistically significant variable ($B = 0.192$, $p = 0.000$). This low explanatory power suggests that stakeholder satisfaction in remote projects is influenced by factors outside of formal risk management strategies, such as interpersonal communication or contractual terms.

5. Discussion

This chapter summarizes the main findings from the statistical analysis and interprets them within the context of the study's objectives and previous research. It also offers practical recommendations for practitioners in the sector, suggestions for future research, and concludes with a final summary of the study's contributions.

5.1 Summary of Results

The study revealed a high level of application of risk management strategies in construction projects in remote areas of Saudi Arabia, with "risk response" being the most frequently applied dimension. This aligns with the findings of Al-Ajmi and McKindi (2018), who emphasized the importance of proactive response planning.

Regression analysis showed that risk management strategies explain 41.5% of the variance in project performance. Specifically, risk monitoring and control emerged as the most significant predictive factor, significantly impacting time, cost, quality, and health, safety, and environmental performance. This finding supports the work of Toth and Sebastian (2014), who emphasized the necessity of continuous monitoring in dynamic risk environments.

Interestingly, while risk identification showed significant impacts on time, cost, and quality, the analysis and response dimensions did not exhibit statistical significance in regression models when other variables were adjusted for. This contrasts with the study by Mazurina et al. (2018), who found all dimensions to be of equal importance, suggesting that in the context of remote areas in Saudi Arabia, continuous risk control is more impactful than initial analysis or planned response strategies.

Health, safety, and environmental performance scored highest among the performance dimensions, likely due to stringent regulations in the Kingdom's energy and infrastructure sectors. However, stakeholder satisfaction was the weakest correlation with risk management strategies, indicating that satisfaction is driven by factors beyond technical risk management.

5.2 Recommendations

Based on the findings, the following recommendations are proposed:

- **Improve Risk Monitoring Systems:** Construction companies should invest in real-time digital monitoring tools to track risk triggers in remote locations, as this was the strongest predictor of project success.

- Strengthen risk monitoring systems: Construction companies should invest in real-time digital monitoring tools to track risk triggers in remote locations, as this was the strongest predictor of project success.
- Enhance risk identification protocols: Formal procedures for early and systematic risk identification should be established, ensuring the participation of all stakeholders before project implementation begins in remote areas.
- Integrate interpersonal stakeholder management skills: Since formal risk management strategies have shown little impact on stakeholder satisfaction, managers should focus on communication and relationship-building strategies alongside technical risk management.
- Adopt a flexible risk response: While response planning is important, its statistical impact has been overshadowed by the impact of monitoring. Companies should adopt flexible methodologies that allow for a rapid response to logistical challenges in remote areas.
- Provide quantitative analysis training: Risk analysis yielded good results but was not a significant indicator. Training staff on advanced quantitative tools (such as Monte Carlo) could help translate the analysis into practical performance improvements.

5.3 Future Studies

- Comparative Study: Conduct a comparative analysis of construction projects in remote and urban areas to isolate the specific impact of "distance" on risk management effectiveness.
- Impact of Technology: Examine the role of artificial intelligence and building information modeling (BIM) in enhancing risk monitoring and control in remote areas.
- Stakeholder Satisfaction Factors: Conduct a qualitative study to explore the non-technical factors that drive stakeholder satisfaction in mega-projects in Saudi Arabia.
- Small vs. Large Companies: Evaluate how company size (Category 1 vs. Category 4) affects the relationship between risk management strategies and performance.

5.4 Conclusion

This study confirms that effective risk management, particularly continuous monitoring and control, is essential for the success of construction projects in remote areas of Saudi Arabia. While the sector demonstrates a strong commitment to safety and quality, there is a pressing

need to focus on the dynamic aspects of risk management to control time and cost overruns. By prioritizing immediate monitoring and early detection, construction companies can better overcome the logistical and environmental challenges of the Kingdom's ambitious development projects.

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